

連鎖律計算をさせようとしてみたところ...

```
[1]: using SymPy
[2]: @syms u v
[2]: (u, v)
[3]: x = u+v
    y = u-v
[3]: u - v
[4]: f = x * y^2 + x^3 * y
    # 代入した瞬間に展開されてしまう..
[4]: (u - v)^2 (u + v) + (u - v)(u + v)^3
[5]: expand( diff( f, u ) )
[5]: 4u^3 + 6u^2v + 3u^2 - 2uv - 2v^3 - v^2
[6]: expand( diff( f, v ) )
[6]: 2u^3 - u^2 - 6uv^2 - 2uv - 4v^3 + 3v^2
```

教育のために連鎖律を表現させてみる

```
[7]: @syms g()
[7]: (g,)
*[8]: h = g(x,y) # 一般形にすれば連鎖律を表示するしかあるまい!
[8]: g(u + v, u - v)
[9]: diff(h, u)
[9]:  $\frac{\partial}{\partial \xi_1} g(\xi_1, u - v) \Big|_{\xi_1 = u + v} + \frac{\partial}{\partial \xi_2} g(u + v, \xi_2) \Big|_{\xi_2 = u - v}$ 
[10]: diff( h, v )
[10]:  $\frac{\partial}{\partial \xi_1} g(\xi_1, u - v) \Big|_{\xi_1 = u + v} - \frac{\partial}{\partial \xi_2} g(u + v, \xi_2) \Big|_{\xi_2 = u - v}$ 
```

接平面を描いてみる

```
[11]: using Plots
[14]: q(x,y) = 4*x^2*y + x * y^3
    s(x,y) = -7x + y - 5
[14]: s (generic function with 1 method)
*[30]: xrange = -2:0.01:0
    yrange = 0:0.01:2

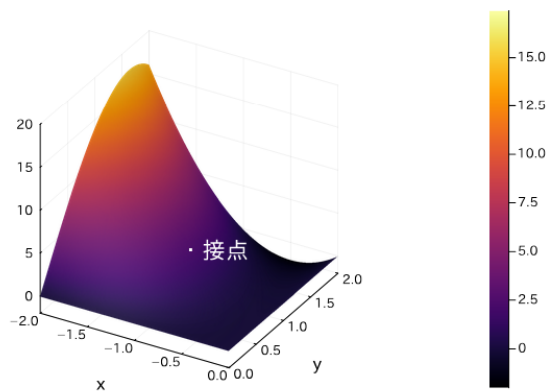
    X = [ x for x in xrange ]
    Y = [ y for y in yrange ]

    Sz = [ q(x,y) for x in xrange, y in yrange ]
    Plane = [ s(x,y) for x in xrange, y in yrange ]

[30]: 201x201 Matrix{Float64}:
  9.0  9.01  9.02  9.03  9.04  ...  10.96  10.97  10.98  10.99  11.0
  8.93  8.94  8.95  8.96  8.97  ...  10.89  10.9  10.91  10.92  10.93
  8.86  8.87  8.88  8.89  8.9  ...  10.82  10.83  10.84  10.85  10.86
  8.79  8.8  8.81  8.82  8.83  ...  10.75  10.76  10.77  10.78  10.79
  8.72  8.73  8.74  8.75  8.76  ...  10.68  10.69  10.7  10.71  10.72
  8.65  8.66  8.67  8.68  8.69  ...  10.61  10.62  10.63  10.64  10.65
  8.58  8.59  8.6  8.61  8.62  ...  10.54  10.55  10.56  10.57  10.58
  8.51  8.52  8.53  8.54  8.55  ...  10.47  10.48  10.49  10.5  10.51
  8.44  8.45  8.46  8.47  8.48  ...  10.4  10.41  10.42  10.43  10.44
  8.37  8.38  8.39  8.4  8.41  ...  10.33  10.34  10.35  10.36  10.37
  8.3  8.31  8.32  8.33  8.34  ...  10.26  10.27  10.28  10.29  10.3
  8.23  8.24  8.25  8.26  8.27  ...  10.19  10.2  10.21  10.22  10.23
  8.16  8.17  8.18  8.19  8.2  ...  10.12  10.13  10.14  10.15  10.16
  ...
 -4.23 -4.22 -4.21 -4.2 -4.19  ... -2.27 -2.26 -2.25 -2.24 -2.23
 -4.3 -4.29 -4.28 -4.27 -4.26  ... -2.34 -2.33 -2.32 -2.31 -2.3
 -4.37 -4.36 -4.35 -4.34 -4.33  ... -2.41 -2.4 -2.39 -2.38 -2.37
 -4.44 -4.43 -4.42 -4.41 -4.4  ... -2.48 -2.47 -2.46 -2.45 -2.44
 -4.51 -4.5 -4.49 -4.48 -4.47  ... -2.55 -2.54 -2.53 -2.52 -2.51
 -4.58 -4.57 -4.56 -4.55 -4.54  ... -2.62 -2.61 -2.6 -2.59 -2.58
 -4.65 -4.64 -4.63 -4.62 -4.61  ... -2.69 -2.68 -2.67 -2.66 -2.65
 -4.72 -4.71 -4.7 -4.69 -4.68  ... -2.76 -2.75 -2.74 -2.73 -2.72
 -4.79 -4.78 -4.77 -4.76 -4.75  ... -2.83 -2.82 -2.81 -2.8 -2.79
 -4.86 -4.85 -4.84 -4.83 -4.82  ... -2.9 -2.89 -2.88 -2.87 -2.86
 -4.93 -4.92 -4.91 -4.9 -4.89  ... -2.97 -2.96 -2.95 -2.94 -2.93
 -5.0 -4.99 -4.98 -4.97 -4.96  ... -3.04 -3.03 -3.02 -3.01 -3.0
```

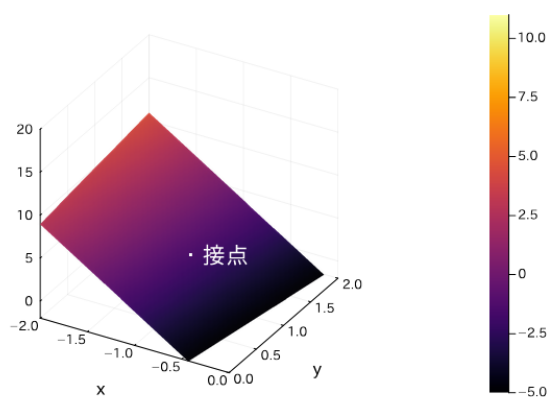
```
[42]: default( xlabel = "x", ylabel = "y", fontfamily = "ipaexg", zlims = (-2,20))
      surface(X, Y, Sz', fill = true )
      annotate!([( -1,1,3,("・接点", :left, :white))])
      # x,y の変化の向きによる行列への値の格納順序が、図の軸の向きと違うので、行列を転置して直している。
```

[42]:



```
[43]: surface(X, Y, Plane')
      annotate!([( -1,1,3,("・接点", :left, :white))])
```

[43]:



[]: